Having thus described the preferred embodiment, the invention is now claimed to be:

1. A method of determining skew of an image in an optical scanning device, said method comprising.

(a) optically scanning a document to produce scanned image data including a plurality of scan lines having ON and OFF pixels,

(b) sampling image data on at least one scan line along (i) a fast scan direction and (ii) a slow scan direction for one document rotation angle to determine a number of ON pixels on each scan line;

(c) from the sampled image data, calculating:

(i) a second order moment of ON pixels on the at least one scan line along the fast scan direction for a plurality of document rotation angles, said calculation yielding a fast scan second order moment data set; and

(ii) a second order moment of ON pixels on the at least one scan line along the slow scan direction for a plurality of document rotation angles, said calculation yielding a slow scan second order moment data set;

(d) calculating a first skew angle estimate from the fast scan second order moment data set,

(e) calculating a second skew angle estimate from the slow scan second order moment data set;

(f) determining whether the fast scan second order moment data set and the slow scan second order moment data set are valid; and

(g) combining calculated skew angle estimates corresponding to valid second order moment data sets to yield a resultant skew angle

2. The method as set forth in claim 1, wherein steps (b) and (c) include.

reading a pixel at a first document rotation angle, said pixel being located on a first scan line;

without rotating the document, projecting the pixel onto other scan lines corresponding to a plurality of predetermined document rotation angles, and,

if the pixel is an ON pixel, simultaneously updating a plurality of counters where each counter corresponds to one of the plurality of predetermined document rotation angles.

3. The method as set forth in claim 1, wherein step (c) includes.

calculating the second order moment of a number of ON pixels in a number of scan lines along the fast scan direction by an equation of the form

$$\sum_{i=1}^{N}(n_i)^2$$

where:

N is the number of scan lines along the fast scan direction,

n is the number of ON pixels in a scan line, and

i is a counter for the scan lines along the fast scan direction,

and

calculating the second order moment of a number of ON pixels in a number of scan lines along the slow scan direction by an equation of the form

$$\sum_{j=1}^{M}(m_j)^2$$

where:

M is the number of scan columns along the slow scan direction,

m is the number of ON pixels in a scan column, and

j is a counter for the scan columns along the slow scan direction.

4. The method as set forth in claim 3, wherein calculating steps (d) and (e) include:

locally fitting the fast scan and slow scan second order moment data sets near $S_{\alpha max}$ with an equation of the form:

$$S_\alpha = S_{\alpha max} - k\,|\,\alpha - \alpha_{max}|$$

where:

$S_{\alpha max}$ is a maximum second order moment; and

α_{max} is the document rotation angle at which $S_{\alpha max}$ occurs,

calculating a first document rotation angle at which the second order moment is substantially a maximum for the fast scan second order moment data set. and

calculating a second document rotation angle at which the second order moment is substantially a maximum for the slow scan second order moment data set.

5 The method as set forth in claim 4, wherein step (f) further includes:

determining whether the fast scan second order moment data set includes a single dominant peak;

determining whether the slow scan second order moment data set includes a single dominant peak; and

invalidating second order moment data sets not having a single dominant peak

6 The method as set forth in claim 5, wherein step (f) further includes:

for second order moment data sets having a single dominant peak, determining whether the dominant peak corresponds to a strictly decreasing function, and

invalidating second order moment data sets not having a dominant peak corresponding to a strictly decreasing function

7. The method as set forth in claim 6, wherein step (f) further includes:

for second order moment data sets having a single dominant peak calculating a first quality factor related to strength of the single dominant peak, and,

comparing the first quality factor to a first predetermined threshold

8. The method as set forth in claim 7, wherein the first quality factor is calculated by an equation of the form:

$$Q_{Global} = \frac{(S_{\alpha\,\max} - S_{\alpha\,\min})}{S_{\alpha\,\max}}$$

where

$S_{\alpha max}$ is a maximum second order moment; and

$S_{\alpha min}$ is a minimum second order moment

9. The method as set forth in claim 8, wherein step (f) further includes:

calculating a second quality factor related to slope of the single dominant peak, and,

comparing the second quality factor to a second predetermined threshold.

10. The method as set forth in claim 9, wherein the second quality factor is calculated by an equation of the form:

$$Q_{loc} = k = \frac{S_\alpha - S_{\alpha\,\max}}{|\,\alpha - \alpha_{\max}\,|}$$

where

$S_{\alpha max}$ is a maximum second order moment, and

α_{max} is the document rotation angle at which $S_{\alpha max}$ occurs

11. The method as set forth in claim 8, wherein step (g) includes

determining how many second order moment data sets are valid,

if neither second order moment data set is valid, (i) declaring failure and (ii) not reporting a resultant skew angle, and,

if one second order moment data set is valid, reporting the skew angle estimate corresponding to the valid second order moment data set.

12. The method as set forth in claim 11, wherein step (g) further includes

if the fast scan and slow scan second order moment data sets are valid, calculating a difference between the first quality factors for the fast scan and slow scan second order moment data sets,

comparing the quality factor difference to a difference threshold, and

if the quality factor difference is greater than the difference threshold, reporting the skew angle estimate corresponding the second order moment data set having a larger first quality factor

13. The method as set forth in claim 12, wherein step (g) further includes:

if the quality factor difference is less than the difference threshold, calculating a skew angle difference between the first and second skew angle estimates,

comparing the skew angle difference to a third predetermined threshold,

if the skew angle difference is greater than the third predetermined threshold, reporting the smaller skew angle estimate; and

if the skew angle difference is less than the third predetermined threshold, averaging the first and second skew angle estimates to yield the resultant skew angle.

14. A method of determining a document skew angle comprising

(a) scanning a document to produce image data made up of scan lines having ON and OFF pixels;

(b) determining a first independent skew angle estimate based on a number of ON pixels on a plurality of scan lines along a fast scan direction,

(c) determining a second independent skew angle estimate based on a number of ON pixels on a plurality of scan columns along a slow scan direction, and

(d) merging the first and second independent skew angle estimates to yield the document skew angle.

15 The method as set forth in claim 14, wherein steps (b) and (c) include.

without rotating the document, simultaneously calculating a second order moment of ON pixels on the scan lines along the fast scan direction at a plurality of document rotation angles, yielding a fast scan order moment data set, and

without rotating the document, simultaneously calculating a second order moment of ON pixels on the scan columns along the slow scan direction at a plurality of document rotation angles, yielding a slow scan second order moment data set.

16. The method as set forth in claim 15, wherein steps (b) and (c) further include:

determining the document rotation angle at which the fast scan second order moment data set is substantially a maximum, and

determining the document rotation angle at which the slow scan second order moment data set is substantially a maximum.

17. The method as set forth in claim 14, wherein step (d) includes

validity testing the fast scan and slow scan second order moment data sets; and

combining independent skew angle estimates corresponding to valid second order moment data sets

18. The method as set forth in claim 17, wherein the validity testing step includes:

calculating at least one quality factor for each second order moment data set relating to at least one of (i) peak amplitude and (ii) peak slope; and

invalidating second order moment data sets having one of (i) multiple peaks, (ii) impure peaks, and (iii) a quality factor less than a predetermined threshold

19 The method as set forth in claim 18, wherein the combining step includes:

determining how many second order moment data sets are valid,

if neither second order moment data set is valid, (i) declaring failure and (ii) not reporting a resultant skew angle, and,

if one second order moment data set is valid, reporting the skew angle estimate corresponding to the valid second order moment data set

20 The method as set forth in claim 19, wherein the combining step further includes:

if both second order moment data sets are valid, comparing at least one of (i) the quality factors, and (ii) the corresponding skew angle estimates of the two valid second order moment data sets; and

in response to the comparing step, reporting one of (i) the first skew angle estimate, (ii) the second skew angle estimate, and (iii) an average of the first and second skew angle estimates

21. A xerographic apparatus programmed to determine image skew of scanned document, said xerographic apparatus comprising:

an imaging platen;

means for scanning successive scan lines of the document, said scan lines having ON pixels and OFF pixels;

a memory for storing scanned image data representing a skewed image,

means for reading a pixel at a first document rotation angle, said pixel being located on a first scan line;

means for projecting the pixel onto other scan lines corresponding to a plurality of predetermined document rotation angles,

a plurality of pixel counters for simultaneously counting a number of ON pixels along a plurality of scan lines and columns,

a skew angle processor which (i) computes first and second independent skew angle estimates based on the number of ON pixels along the plurality of scan lines and columns, and (ii) merges the first and second independent skew angle estimates to yield a resultant skew angle;

an image processor for correcting the skewed image in accordance with the resultant skew angle,

means for transferring an image charge pattern onto a photoreceptor,

at least one developing station for developing the charge pattern, and

at least one fuser for fixing a developed image onto a physical media